Development of Heavy-duty Vehicle Fuel Consumption Standards in China

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Overviews

1. Background
2. Standard framework
3. Implementation and administration
4. Collaborative control of FC and pollutant emissions
5. Other following works
Production and sales

- In recent years, the production, sales and capacity of China’s auto increased a lot. In 2012, the production and sales of auto were both more than 19 millions in China that is the largest auto producing and consuming country.
- Vehicles with GVW more than 3.5 ton takes up nearly 10%. In the recent years, the sales slipped affected by the economy situation, but still maintain nearly at 2 millions.
Market

At present, there are more than 600 HDV manufacturers in China, however most are special vehicle refitting factories and have small production volume.

The market concentration is high. The top ten manufacturers share more than 90% of trucks and semi-trailer tractors market and 80% of buses and dumpers in China.
Oil consumption

- In 2010, China consumed 68 million tons of petrol which were almost consumed by road transportation, and 94 million tons of diesel oil of which 85% were consumed by road transportation. \[a\]

- As high fuel consumption and long annual distance, HDV nearly consumed half of total oil consumption of all vehicles.

- Among the HDVs, trucks and semi-trailer tractors which apply to long-distance transportation take the large percentage of the total diesel oil.

\[a\] Data from EF.
Background and process of standard establishing

From 2001, China began researching on automobile fuel consumption standards and established light-duty vehicle fuel consumption standard system.

In 2008, China started establishing heavy-duty vehicles fuel consumption standard formally.

Until present, China has finished and issued a few core standards, and established heavy-duty vehicle fuel consumption standard system.
### Standard framework

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issued and implemented</td>
<td>• HDV fuel consumption test methods</td>
</tr>
<tr>
<td>Issued and implemented</td>
<td>• HDV fuel consumption limits (the first stage)</td>
</tr>
<tr>
<td>To be issued</td>
<td>• HDV fuel consumption limits (the second stage)</td>
</tr>
<tr>
<td>Preliminary research</td>
<td>• Collaborative control of fuel consumption and pollutant emissions of HDVs</td>
</tr>
<tr>
<td>Preliminary research</td>
<td>• Driving cycles of HDVs</td>
</tr>
<tr>
<td>Preliminary research</td>
<td>• Fuel consumption labels of HDVs</td>
</tr>
</tbody>
</table>
Test methods

- FC of HDVS (Pollutant emissions)
  - Basic types
  - Chassis dyno tests
  - Coastdown data or recommended values
  - Simulation
  - Engine data
    - C-WTVC
      - City, rural and highway FC (Pollutant emissions)
      - Combined FC (Pollutant emissions)

Blue: to promote in the future
Test methods

- C-WTVC driving cycle, adjusted vehicle and acceleration based on WTVC. [b]

- Weighted factors were determined based on survey data.

- In the future, actual fuel consumption on the road is planned to be investigated to refine the weighted factors.

[b] As China do not have a driving cycle of HD, thus WHDC was modified and adopted.
Test methods

- FC of gasoline and diesel HDVs could be calculated.
- Based on the engine data, FC is calculated by inputting resistance and other parameters.

- FC of basic types and HEVs could be tested according to chassis dyno testing.
## Fuel consumption limits

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Industry standard (the first stage)</th>
<th>National standard (the second stage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Bus</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Semi-trailer tractor</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>City bus</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Dumper</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Special work vehicle</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Special transport vehicle</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Fuel consumption limits

FC consumption limits are set for vehicle types. The limits of the first and second stage of trucks are as follows:

Limits of the second stage are 10.5%~14% stricter than that of first stage.

<table>
<thead>
<tr>
<th>Gross Vehicle Weight (kg)</th>
<th>FC limits (the first stage) L/100km</th>
<th>FC limits (the second stage) L/100km</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 500 &lt; GVW≤4 500</td>
<td>15.5</td>
<td>13.0</td>
</tr>
<tr>
<td>4 500 &lt; GVW≤5 500</td>
<td>16.5</td>
<td>14.0</td>
</tr>
<tr>
<td>5 500 &lt; GVW≤7 000</td>
<td>18.5</td>
<td>16.0</td>
</tr>
<tr>
<td>7 000 &lt; GVW≤8 500</td>
<td>22.0</td>
<td>19.0</td>
</tr>
<tr>
<td>8 500 &lt; GVW≤10 500</td>
<td>24.0</td>
<td>21.5</td>
</tr>
<tr>
<td>10 500 &lt; GVW≤12 500</td>
<td>28.0</td>
<td>25.0</td>
</tr>
<tr>
<td>12 500 &lt; GVW≤16 000</td>
<td>31.0</td>
<td>28.0</td>
</tr>
<tr>
<td>16 000 &lt; GVW≤20 000</td>
<td>35.0</td>
<td>31.5</td>
</tr>
<tr>
<td>20 000 &lt; GVW≤25 000</td>
<td>41.0</td>
<td>37.5</td>
</tr>
<tr>
<td>25 000 &lt; GVW≤31 000</td>
<td>47.5</td>
<td>43.0</td>
</tr>
<tr>
<td>31 000 &lt; GVW</td>
<td>50.0</td>
<td>45.5</td>
</tr>
</tbody>
</table>
Standard framework

Fuel consumption limits

- “L/100km” is adopted as the unit

- Groups are divided by GVW. As the groups are dense at the small weight and concentrated to the upper bound at the large weight, thus the actual effects almost same to the “L/100(t*km)”.

- In future, keep on research on other units like “L/100(t*km)” for trucks and “L/100(seat*km)” for buses.
Standard framework

Fuel consumption limits

According to estimate, after the implement of the second stage limits, the average FC of five vehicle types will decrease 8.6~11%.
Implement and administration

In Jan. 2012, the MIIT and MOT released a joint notice of “Heavy duty vehicle fuel consumption energy saving administration”

- From Feb. 2012, HDV fuel consumption standard (phase 1) was implemented
- All vehicle types must satisfy the limits to enter the market

In Jan. 2012, based on MIIT’s notice, CVTSC released specific implement rules (temporary)

- Definitions of vehicle family, basic type and variant types are specified.
## Implement status

<table>
<thead>
<tr>
<th>Items</th>
<th>~2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015~</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test method</td>
<td>Establishing</td>
<td>Issued at the end of 2011</td>
<td>Implement</td>
<td></td>
<td></td>
<td>Implement</td>
</tr>
<tr>
<td>FC limits (the 1st stage) (industry standard)</td>
<td>Establishing</td>
<td>Issued at the end of 2011</td>
<td>Implement of new vehicle type</td>
<td>Implement of vehicle type under producing</td>
<td>Implement of vehicle type under producing</td>
<td>Implement of vehicle type under producing</td>
</tr>
<tr>
<td>FC limits (the 2nd stage) (national standard)</td>
<td>Currently establishing</td>
<td>TBT notification (WTO approval)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Implement and administration

- Estimate of implement effect
  - Based on 2012, estimate the implement effect from 2013 to 2015.

- From 2013 to 2015, as the implement of standards, 4.98 million tons of diesel oil will saved of HDVs, and 15.6 million tons of CO₂ will reduced.

- If the price of diesel oil is calculated as 7.5 ¥/L in China, 44.8 billion ¥ will be saved.
Total pollutant emissions

In 2011, vehicles exhausted 37 million tons of pollutants in China. Diesel vehicles account for 67.4% and 99% of total NOx and PM emissions. At present, diesel vehicles are mainly HDVs. [c]

If estimate LDVs emissions as EURO IV and HDVs as EURO III, for the new vehicles producing in one year, HDVs exhaust 3.9 times NOx and 12.8 times PM of LDVs.

[c] Data from VECC
Collaborative control of FC and pollutant emission

Existing Problems

1. Performances of vehicle can not be reflected
   - Engine bench tests of pollutants and the unit of “g/kWh” can not reflect resistance, tire and other effects.

2. Differences between test results and actual emissions on road
   - Large differences exist between the engine bench test results and actual vehicle emissions on road.

3. Disjoint of FC and pollutant emissions administration
   - As FC and pollutant emissions tests are carried out on the whole vehicle and engine bench separately, manufacturers could cope with the regulations and administration with different ECU control strategies.
Collaborative control of FC and pollutant emissions

- **Purpose**

As the HDV FC test methods based on “Chassis dyno + simulation” has been implemented, China has owned the ability to measure the pollutant emissions of HDVs on the chassis dyno. Promote the collaborative control of FC and pollutant emissions could:

- Control the total amount of oil consumption and pollutant emissions of HDVs
- Reflect the actual pollutant emissions of engine on the vehicle
- Avoid that manufacturers coping with regulations with different ECU control strategies.
Collaborative control of FC and pollutant emissions

- Research route and challenge

1. Driving cycle (C-WTVC, WTVC and etc.)
2. Chassis dyno test procedure and key problems (cold start)
3. Comparison between g/kWh and g/km
4. Definitions of basic and variant types (differences between FC and pollutant emissions)
5. Policy suggestion and implement schemes of collaborative control for the government.
## Comparison between g/kWh and g/km

<table>
<thead>
<tr>
<th>g/kWh</th>
<th>g/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Based on the “work”, use pollutant emissions per output work to evaluate the performance of engine.</td>
<td></td>
</tr>
<tr>
<td>• Can not reflect resistance, transmission, tire and other influencing factors.</td>
<td></td>
</tr>
<tr>
<td>• Based on the “distance”, use pollutant emissions per distance to evaluate the performance of the whole vehicle.</td>
<td></td>
</tr>
<tr>
<td>• Can reflect.</td>
<td></td>
</tr>
</tbody>
</table>

According to calculation model or data from OBD, g/kWh and g/km could be converted to each other.
Current definitions of basic and variant vehicle types

The same vehicle family should have no differences on the following aspects:

- Basic vehicle type is defined as the “the worst fuel consumption”, for example, the largest mass, front area and final rear ratio in the vehicle family.

Following research

- Pollutant emissions cannot be calculated by the simulation model. Differences between the vehicle family and basic type definitions FC and pollutant emissions?

- Add FC differences as the conditions of vehicle family.
### Other following works

<table>
<thead>
<tr>
<th>Collaborative control</th>
<th>Fuel consumption labels</th>
</tr>
</thead>
</table>
| ● Research on the Collaborative control of FC and pollutant emissions of HDVs based on the chassis dyno testing. | ● Compare the test results to the actual fuel consumption on the road.  
● Research on feasibilities of labels of HDVs. |

<table>
<thead>
<tr>
<th>Refining of the test methods</th>
<th>Limits for 2020</th>
</tr>
</thead>
</table>
| ● Refine the simulation model.  
● Research on feasibilities of simulate the energy consumption of HEVs and EVs.  
● Refine the test procedure of chassis dyno. | ● Research on the third stage limits for 2020.  
● Research on the evaluation system, technology energy saving potential and costs. |
Thank You

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